PATENT APPLICATION
Attorney Docket No. 2204-012023

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of	:	
Junichi KATSUKI	:	AUSTENITIC STAINLESS STEEL LESS
Teruyoshi IIDA	:	SUSCEPTIBLE TO CRACKING DURING
Takashi YAMAUCHI	:	FORMING AND A MANUFACTURING
Satoshi SUZUKI	:	METHOD THEREOF
Naoto HIRAMATSU	:	
Serial No. Not Yet Assigned	:	
Filed Concurrently Herewith	:	

Pittsburgh, Pennsylvania
January 8, 2002

PRELIMINARY AMENDMENT

Box New Application
Commissioner for Patents
Washington, D.C. 20231

Sir:

IN THE SPECIFICATION:

Please insert and amend section headings and amend specification paragraphs as follows.

Please replace the title beginning at page 1, line 1 with the following rewritten title:

AUSTENITIC STAINLESS STEEL LESS SUSCEPTIBLE TO CRACKING DURING FORMING AND A MANUFACTURING METHOD THEREOF

On page 1, before line 5, please insert the following section heading:

1. Field of the Invention

Please replace the paragraph beginning at page 1, line 5 with the following rewritten paragraph:

The present invention relates to an austenitic stainless steel that has good formability and is less susceptible to cracking during forming, and also relates to a method of manufacturing thereof.

On page 1, before line 9, please insert the following section heading:

2. Description of Related Art

Please replace the paragraph beginning at page 2, line 19 with the following rewritten paragraph:

The present invention proposes a new austenitic stainless steel less susceptible to cracking during forming, which has the composition consisting of C up to 0.04 mass %, 0.1-1 mass % Si, Mn up to 5.0 mass %, S up to 0.0060 mass %, Al up to 0.003 mass %, 5-9 mass % Ni, 15-20 mass % Cr, N up to 0.035 mass %, 1.0-5.0 mass % Cu and the balance being Fe except inevitable impurities. Nonmetallic MnO-SiO_2-Al_2O_3 inclusions, which contains not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3, is dispersed as fine particles in a steel matrix.

Please replace the paragraph beginning at page 3, line 10 with the following rewritten paragraph:

The inventors have searched and examined effects of deoxidizing and refining conditions on formability of an austenitic stainless steel sheet containing approximately 0-0.4 mass % C, approximately 0.1-1.0 mass % Si, approximately 0-5.0 mass % Mn, approximately 5-9 mass % Ni, approximately 15-20 mass % Cr, approximately 0-0.035 mass % N, approximately 0-0.0060 mass % S and approximately 1.0-5.0 mass % Cu. After the austenitic stainless steel was deoxidized and refined in various conditions, it was hot-rolled and cold-rolled to a thickness of approximately 0.3 mm.

Please replace the paragraph beginning at page 6, line 21 with the following rewritten paragraph:

When nonmetallic inclusion is converted to $MnO-SiO_2-Al_2O_3$ containing not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3, it is divided to fine harmless size by hot-rolling and cold-rolling so as to decrease its susceptibility to cracking during forming. If the nonmetallic inclusion contains less than 15 mass % of SiO_2 or more than 40 mass % of Al_2O_3, it is changed to galaxite, which is hardly divided by hot- and cold-rolling. In this case, cracking easily occurs during forming a steel sheet to an objective shape. Therefore, the nonmetallic inclusion shall be converted to $MnO-SiO_2-Al_2O_3$ containing not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3.

Please replace the paragraph beginning at page 13, line 1 with the following rewritten paragraph:

According to the present invention as above-mentioned, austenitic stainless steel, which contains Si and Al at controlled ratios, is refined and deoxidized with a Si alloy whose Al content is restricted under a certain level, so as to make up a structure wherein nonmetallic inclusion is minutely dispersed as $MnO-SiO_2-Al_2O_3$ inclusion in a steel sheet. Since the austenitic stainless steel sheet can be formed to an objective shape without occurrence of cracking due to a decrease in its susceptibility to cracking, it is useful as steel members or parts in various industrial fields.

IN THE CLAIMS:

Please cancel pending claims 1 and 2 and add new claims 3-10 as follows.

3. An austenitic stainless steel that is less susceptible to cracking during forming, which has a composition comprising approximately 0-0.04 mass % C, approximately 0.1-1.0 mass % Si, approximately 0-5.0 mass % of Mn, approximately 0-0.0060 mass % S, approximately 0-0.003 mass % Al, approximately 5-9 mass % Ni,

approximately 15-20 mass % Cr, approximately 0-0.035 mass % N, approximately 1.0-5.0 mass % Cu and the balance being Fe except inevitable impurities, and has nonmetallic MnO-SiO_2-Al_2O_3 inclusions, which contains not less than approximately 15 mass % of SiO_2 and not more than approximately 40 mass % of Al_2O_3, dispersed in its matrix.

4. A method of manufacturing austenitic stainless steel, which comprises the steps of:

preparing a molten steel having the composition comprising approximately 0-0.04 mass % C, approximately 0.1-1.0 mass % Si, approximately 0-5.0 mass % Mn, approximately 0-0.0060 mass % S, approximately 0-0.003 mass % Al, approximately 5-9 mass % Ni, approximately 15-20 mass % Cr, approximately 0-0.035 mass % N, approximately 1.0-5.0 mass % Cu and the balance being Fe except inevitable impurities;

covering said molten steel with basic slag in a vacuum or non-oxidizing atmosphere; and

deoxidizing said molten steel by addition of a Si alloy whose Al content is controlled less than approximately 1.0 mass %.

5. The austenitic stainless steel according to claim 3, further including a boron content up to a max of 0.03 mass %, if the sulfur content is greater than 0.0030 mass %.

6. The austenitic stainless steel according to claim 3, wherein the composition preferably has a value of $d \leq 0$ and $a > 0$, where

$d = 1.9\,Ni + 32C + 27N + 0.15\,(Mn + Cu) - 1.5Cr + 8.5$ and

$a = Ni + 0.5Cr + 0.7\,(Mn + Cu) - 18.$

7. The method of manufacturing austenitic stainless steel according to claim 4, further comprising the step of achieving not less than approximately 15 mass % of

SiO_2 and not more than approximately 40 mass % of Al_2O_3 dispersed in the matrix of the solidified steel.

8. The method of manufacturing austenitic stainless steel according to claim 4, further comprising the step of adding boron up to a max of 0.03 mass %, if the sulfur content is greater than 0.0030 mass %.

9. The method of manufacturing austenitic stainless steel according to claim 4, further including the step of keeping the basicity of the slag preferably in a range of 1.4-3.0.

10. The method of manufacturing austenitic stainless steel according to claim 4, further comprising the step of achieving a composition preferably with a value of $d \leq 0$ and $a > 0$ where

$$d = 1.9\,Ni + 32C + 27N + 0.15(Mn+Cu) - 1.5Cr + 8.5 \text{ and}$$

$$a = Ni + 0.5Cr + 0.7\,(Mn + Cu) - 18.$$

IN THE ABSTRACT:

Please replace the section heading beginning at page 15, line 1 with the following rewritten section heading:

ABSTRACT OF THE DISCLOSURE

Please replace the paragraph beginning at page 15, line 3 with the following rewritten paragraph:

A new austenitic stainless steel containing approximately 0.1-1.0 mass % of Si and not more than approximately 0.003 mass % of Al. Nonmetallic inclusions dispersed in a steel matrix are converted to MnO-SiO2-Al2O3 containing not less than approximately 15 mass % of SiO2 and not more than approximately 40 mass % of Al2O3. During steel making, molten steel is covered with basic slag and heavily deoxidized with a Si alloy whose Al content is controlled to not more than approximately 1.0 mass % in a vacuum or non-

oxidizing atmosphere. The austenitic stainless steel sheet can be formed to an objective shape without the occurrence of cracking due to its decrease in susceptibility to cracking and its good formability.

REMARKS

The specification has been amended to place the application in conformance with standard United States patent practice. Claims 1 and 2 have been cancelled and new claims 3-10 have been added to conform the claims to standard United States patent practice and to further define the invention.

Attached hereto is a marked-up version of the changes made to the specification by the current amendment. The attachment is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE".

Examination and allowance of pending claims 3-10 are respectfully requested.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

In the specification:

Title beginning at page 1, line 1 has been amended as follows:

[AN] AUSTENITIC STAINLESS STEEL LESS [CRACK-SENSITIVE] SUSCEPTIBLE TO CRACKING DURING FORMING AND A MANUFACTURING METHOD THEREOF

Paragraph beginning at page 1, line 5 has been amended as follows:

The present invention relates to an austenitic stainless steel [good of] that has good formability and [less crack-sensitive] is less susceptible to cracking during forming, and also relates to a method of manufacturing thereof.

Paragraph beginning at page 2, line 19 has been amended as follows:

The present invention proposes a new austenitic stainless steel less [crack-sensitive] susceptible to cracking during forming, which has the composition consisting of C up to 0.04 mass %, 0.1-1 mass % Si, Mn up to 5.0 mass %, S up to 0.0060 mass %, Al up to 0.003 mass %, 5-9 mass % Ni, 15-20 mass % Cr, N up to 0.035 mass %, 1.0-5.0 mass % Cu and the balance being Fe except inevitable impurities. Nonmetallic MnO-SiO_2-Al_2O_3 inclusions, which contains not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3, is dispersed as fine particles in a steel matrix.

Paragraph beginning at page 3, line 10 has been amended as follows:

The inventors have searched and examined effects of deoxidizing and refining conditions on formability of an austenitic stainless steel sheet containing [C up to 0.04 mass %,] approximately 0-0.4 mass % C, approximately 0.1-1.0 mass % Si, [Mn up to 5.0 mass %,] approximately 0-5.0 mass % Mn, approximately 5-9 mass % Ni, approximately 15-20 mass % Cr, [N up to 0.035 mass %, S up to 0.0060]

approximately 0-0.035 mass % N, approximately 0-0.0060 mass % S and approximately 1.0-5.0 mass % Cu. After the austenitic stainless steel was deoxidized and refined in various conditions, it was hot-rolled and cold-rolled to a thickness of approximately 0.3 mm.

Paragraph beginning at page 6, line 21 has been amended as follows:

When nonmetallic inclusion is converted to $MnO-SiO_2-Al_2O_3$ containing not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3, it is divided to fine harmless size by hot-rolling and cold-rolling so as to [lower crack-sensitivity] decrease its susceptibility to cracking during forming. If the nonmetallic inclusion contains less than 15 mass % of SiO_2 or more than 40 mass % of Al_2O_3, it is changed to galaxite, which is hardly divided by hot- and cold-rolling. In this case, cracking easily occurs during forming a steel sheet to an objective shape. Therefore, the nonmetallic inclusion shall be converted to $MnO-SiO_2-Al_2O_3$ containing not less than 15 mass % of SiO_2 and not more than 40 mass % of Al_2O_3.

Paragraph beginning at page 13, line 1 has been amended as follows:

According to the present invention as above-mentioned, austenitic stainless steel, which contains Si and Al at controlled ratios, is refined and deoxidized with a Si alloy whose Al content is restricted under a certain level, so as to make up a structure wherein nonmetallic inclusion is minutely dispersed as $MnO-SiO_2-Al_2O_3$ inclusion in a steel sheet. Since the austenitic stainless steel sheet can be formed to an objective shape without occurrence of cracking due to [its less crack-sensitivity] a decrease in its susceptibility to cracking, it is useful as steel members or parts in various industrial fields.

In the abstract:

The section heading beginning at page 15, line 1 has been amended as follows:

ABSTRACT OF THE DISCLOSURE

Paragraph beginning at page 15, line 3 has been amended as follows:

A new austenitic stainless steel [contains] containing approximately 0.1-1.0 mass % of Si and not more than approximately 0.003 mass % of Al. Nonmetallic [inclusion] inclusions dispersed in a steel matrix [is] are converted to $MnO-SiO_2-Al_2O_3$ containing not less than approximately 15 mass % of SiO_2 and not more than approximately 40 mass % of Al_2O_3. During steel making, molten steel is covered with basic slag and [strongly] heavily deoxidized with a Si alloy whose Al content is controlled to not more than approximately 1.0 mass % in a vacuum or non-oxidizing atmosphere. The austenitic stainless steel sheet can be formed to an objective shape without the occurrence of cracking due to its [less crack-sensitivity] decrease in susceptibility to cracking and its good formability.